Exemption No. 13180

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
RENTON, WASHINGTON 98057-3356

In the matter of the petition of **The Boeing Company** for an exemption from §§ 25.901(c) and 25.981(a)(3) of Title 14, Code of Federal Regulations	**Regulatory Docket No. FAA-2015-2021**

GRANT OF EXEMPTION

By letter no. CP-L4L-15-00191, dated May 21, 2015, Mr. Tim Hendrix, Manager, Certification & Airworthiness, The Boeing Company, Boeing Commercial Airplanes, Southern California Engineering Design Center, 2401 E. Wardlow Road, Mail Code D800-0022, Long Beach, CA 90807-5309, petitioned the Federal Aviation Administration (FAA) for an exemption from the requirements of §§ 25.901(c) and 25.981(a)(3) of Title 14, Code of Federal Regulations (14 CFR). This exemption, if granted would allow planned changes for the 757-200 (freighters only) and 757-200PF center-wing-tank (CWT) Fuel Quantity Indication System (FQIS) fuselage wiring installation.

The petitioner requests relief from the following regulation(s):

Section 25.901(c) at Amendment 25-126 – Installation.

For each powerplant and auxiliary power unit installation, it must be established that no single failure or malfunction or probable combination of failures will jeopardize the safe operation of the airplane except that the failure of structural elements need not be considered if the probability of such failure is extremely remote.

Section 25.981(a)(3) – Fuel tank ignition prevention.

(a) No ignition source may be present at each point in the fuel tank or fuel tank system where catastrophic failure could occur due to ignition of fuel or vapors. This must be shown by:

(3) Demonstrating that an ignition source could not result from each single failure, from each single failure in combination with each latent failure condition not shown to be extremely remote, and from all combinations of failures not shown to be extremely

improbable. The effects of manufacturing variability, aging, wear, corrosion, and likely damage must be considered.

Related sections of 14 CFR:

Section 25.1309 – Equipment, systems, and installations, states that required equipment, systems, and installations be designed to ensure that they perform their intended functions under any foreseeable operating condition, and that the occurrence of any failure condition that would prevent the continued safe flight and landing of the airplane be extremely improbable.

The petitioner supports its request with the following information:

This section quotes the relevant information from the petitioner's request, with minor edits for clarity. The complete petition is available at the Department of Transportation's Federal Docket Management System, on the Internet at http://regulations.gov, in docket no. FAA-2015-2021.

Background:

The FAA has issued NPRM 2011-NM-094-AD [a proposed airworthiness directive (AD)], which would require modifying the FQIS wiring or fuel tank systems to prevent development of an ignition source inside the center fuel tank. Paragraph (h)(2) states: "Within 72 months after the effective date of this AD, modify the airplane by separating FQIS wiring that runs between the FQIS processor and the center fuel tank, including any circuits that might pass through a main fuel tank, from other airplane wiring that is not intrinsically safe."

Boeing is proposing to accomplish the FAA's planned AD-mandated changes to separate the FQIS CWT wiring between the FQIS processor and the center fuel tank, as well as using the FQIS Built-In Test Equipment (BITE) check. The BITE service bulletin (SB) 757-28-0136 is already approved by the FAA. The CWT FQIS wiring separation is being prepared with guidance from the FAA's approved standard for retrofit wire separation from FQIS wiring. But the combination of BITE and wire separation will not result in the FQIS system being compliant to §§ 25.901(c) [25-126] and 25.981 (a)(3) [25-125]. Since the wiring changes are a change to type design, but will not be compliant, an exemption is being petitioned. FAA's response to the reference a) NPRM comment suggest that FAA will accept petitions for exemption for the "latent-plus-one" requirements of sections 25.901(c) and 25.981(a)(3) of the Federal Aviation Regulations.

This petition for an exemption is being made since full compliance to these rules for the 757 would require extensive system design/installation changes, but do not substantially improve the safety of the current airplane design, and are economically prohibitive given that the 757 freighter fleet is limited, and so are not in the public's interest.

The FQIS system was previously shown compliant to §§ 25.1309 and 25.901(c) for TC [type certificate] and ATC [amended type certificate]; however, both § 25.901(c) [25-126] and § 25.981(a)(3) [25-125] have additional failure-combination requirements. For systems that may cause a catastrophic hazard, § 25.1309 requires no single failure and no combination of failures greater than extremely improbable; § 25.901(c) [25-126] requires no single failure or probable combination of failures; and § 25.981(a)(3) [25-125]

requires no single failure, no single plus latent (greater than extremely remote), and no multiple combination greater than extremely improbable.

This exemption is being sought for the no single plus latent (greater than extremely remote) as is stated in § 25.981(a)(3) and interpreted by the FAA for § 25.901(c). An exemption is also being sought for the non-environmental aspects of § 25.901(c) provided by FAA interpretation, and the explicit § 25.981(a)(3) requirements of manufacturing variability, aging, wear, corrosion, and likely damage, as these considerations are already covered by airline maintenance of the type design of the airplane.

Statement of Public Interest:

Without exemption relief for the FQIS CWT wiring changes, the intent of the NPRM and the FAA's previous communication of intent for airplane design improvement for the CWT FQIS, to address those 757 freighters that do not have Nitrogen Generating System (NGS), cannot be met. For compliance, airplane changes to the entire FQIS (all tanks) would be required for fleet retrofit such as:

- New system architecture to redesign the FQPU [Fuel Quantity Processing Unit] to function as a Hot Short Protector (HSP[1]) Line-Replaceable Unit (LRU) and relocate the FQPU to enable wire separation. Other architectures could be used such as providing a HSP LRU closer to the tank, but it would be a more extensive and new architecture.
- Extensive airplane wiring changes to ensure adequate wire separation throughout the FQIS.
- In-tank component changes (new brackets, potential need for shorter probes, revised in-tank wire harness and retention means).
- Software changes related to Fuel Tank Gauging Function and safety function if shorter probes are required.

The current FQIS has been thoroughly evaluated for safety aspects as was required per SFAR 88 for the Fuel Quantity Indicating System, however the FAA determined there were safety issues identified with FQIS wiring connected into a high-flammability tank, for the 757 it is the CWT. The time needed to successfully design and implement system changes beyond the proposed CWT FQIS wiring separation design changes, to comply with the rules, would further impact the availability of the wiring change on this out-of-production fleet of 757 aircraft. These new, complete, FQIS design changes would not provide any economic benefit to the operators and do not provide any significant benefit or increased level of safety. The Boeing Company considers that the granting of this exemption would negate the need for FAA to evaluate the additional data required to support compliance with these regulations. Therefore, granting this exemption would reduce the burden on FAA resources and consequently public expenditure.

Granting this exemption is in the public interest for the aforementioned reasons and will:

[1] A HSP is an LRU that is also designed to have the function to protect the tank circuit wiring from electrical-power-source threats that could affect the airplane circuit wiring of the LRU (FQPU).

- Enhance the safety of the 757 fleet (as has been determined by the FAA) for those airplanes not installing NGS by adding wiring changes for the CWT FQIS.
- Enhance the safety of the 757 fleet, by also including FQIS BITE interval checks for the CWT so that, when done in addition with the CWT FQIS wiring separation, the airplane addresses the single-plus-latent failure modes for the FQIS, which was the probable failure combination indicated by the NTSB.

Statement of No Adverse Effect on Safety:

The addition of the FQIS CWT wiring changes, along with a BITE interval check, in lieu of a fully compliant (all tanks) FQIS (which would have a HSP FQPU LRU, wire separation for the tank circuit wiring (both outside and inside the tank), and a fault detecting BITE that is annunciated), does not have an adverse effect on safety.

In the proposed CWT FQIS wire-separation design change, the ignition-source threat from other airplane systems is reduced since the wiring will have increased separation. There are also Instructions for Continued Airworthiness (ICA) that ensure that any other system changes will continue to maintain the separation provided by this proposed design change, which will now clearly be visually identified as FQIS wiring.

Together, this improves the wiring failure modes, and improves the system probability relative to fuel-tank ignition. With the addition of the FQIS BITE interval checks for the CWT, the probability is better since the exposure of wiring failures will be further reduced.

For the CWT FQIS, where the changes to the FQIS are being done instead of the installation of NGS as determined by the FAA to be an acceptable substitute safety improvement, the combination of the separation, the ICA, and the BITE addresses no single failures in combination with latent failures with an acceptable level of safety by ensuring the continued integrity of protection features from threats to the tank circuit wiring.

> A: The fault modes of the in-tank wiring have reduced exposure to 750 hours due to the BITE check. Wiring inside the tank is well protected and has a very low failure probability which is improved by the lower exposure.
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> B1: The FQPU is a HSP up to 28V. If a low-probability, higher-voltage power source short were to occur on the airplane side of the FQPU or within the FQPU, it most likely would, but for specific failures may not stop it from propagating through to the tank circuits, but the failure would at least be detectable when the BITE interval check was done, and in most cases sooner, as it would most likely affect indication.
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> B2: The wiring from the FQPU to the tank will have separation provided by the AD-mandated service bulletin. This wiring has low probability failure modes which also have reduced exposure provided by the 750 hour interval BITE check.

Whether the failure is A, or B1, or B2, there is no single failure. For the combination of failures, A and B1, or A and B2, the BITE has reduced the exposure and the latency interval for each protection-design feature (wiring has less than extremely remote failure

rates), and so the probability for each failure mode is better than remote. This also addresses the single-plus-latent failure requirement, with an acceptable level of safety, as the probability of either failure on the flight before the next interval check would both be better than remote.

The 757 FQIS was found to be compliant to § 25.901(c) during airplane type certification for the FQIS change in1992, and since then Boeing has completed the SFAR 88 safety assessment and has increased the airplane fuel-system safety with installation of a Hot Short Protector (HSP) LRU for the densitometer.

Following the SFAR 88 system-safety assessments, Boeing assessment was that the risks for the 757 FQIS installation were extremely improbable, which is the typical industry and CFR § 25.1309 standard for an acceptable safety for systems.

The Boeing approach to incorporate design changes to add center wing tank FQIS wire separation with visual identification, a CWT FQIS 750-hour BITE check, along with ICA that ensures that added systems wiring will maintain the separation for the life of the airplane, and the densitometer tank-circuit HSP provided by Boeing SB 757-28A0085, will provide for an enhanced safety margin over the existing, approved FQIS on the in-service fleet.

Request to Waive Publication and Comment:

Since NPRM 2011-NM-094-AD, directly connected to this change, makes mention of this petition for exemption, and has already gone through public-commenting process, Boeing respectfully requests that the FAA waive the “publication and comment” step in the process for making a final decision on this exemption.

Additionally, given that the FAA and Boeing have made a rapid schedule for this project, and so the schedule-sensitive nature of this request for exemption, Boeing respectfully requests that the FAA waive the “publication and comment” step in the process for making a final decision on this exemption. In addition to the timeliness concern, it is the Boeing position that the safety-associated aspects related to this system have been fully vetted in the public forum as part of the SFAR 88 project.

Privileges of the Exemption Outside the United States:

Per 14 CFR 11.81(h), Boeing requests that the privileges of this exemption be extended outside the United States. This extension of privileges is necessary for operations based within foreign countries having bilateral agreements with the United States accepting FAA 14 CFR part 25 as their airworthiness standards for transport category aircraft.

Conclusion:

In accordance to the requirements of 14 CFR § 11.81(e), The Boeing Company has provided a means of compliance to the FAA to establish an acceptable level of safety to that provided by the rules 14 CFR § 25.901(c) and 14 CFR § 25.981(a)(3) by separating the FQIS wiring from other airplane power wires that will meet the minimum separation requirements for most of the wire runs.

For the areas that minimum separation are not achievable due to space limitation, other positive separation means, such as clamps, spacers and sleeving will be used for the CWT FQIS and also including FQIS BITE interval checks for the CWT. These design changes address the single-plus-latent failure modes for the FQIS, which was the probable failure combination indicated by the NTSB report, reference b). Therefore, granting this exemption would, in turn, reduce the burden on FAA resources and consequently public expenditure.

Federal Register publication

Although the petitioner requested that action on its petition not be delayed for publication in the Federal Register, the FAA found that the petition, if granted, would set a precedent. Therefore, to allow an opportunity for the public to comment on the petition, a summary of it was published in the Federal Register on July 22, 2015 (80 FR 43551). Comments were received from the National Air Traffic Control Association (NATCA) National Safety Committee. The following quotes the NATCA comments, with minor edits for clarity.

> NATCA does not support the petition for exemption published in docket no. FAA-2015-2021 and strongly recommends that the FAA denies this petition.
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> This petition requests an exemption "from the Title 14 Code of Federal Regulations 25.901(c) Amendment 25- 126 and 14 CFR 25.981 (a)(3) Amendment 25-125 pertaining to planned changes for the 757-200 (Freighters Only), 757-200PF Center Wing Tank (CWT) Fuel Quantity Indication System (FQIS) Fuselage Wiring Installation." The petition states that it is related to the FAA Supplemental Notice of Proposed Rulemaking (SNPRM) 2011-NM-094-AD. That SNPRM was published as the result of unsafe conditions identified in design reviews performed by Design Approval Holders that were required by 14 CFR part 21 Special Federal Airworthiness Regulation No. 88 (SFAR 88) that was issued by the FAA in 2001. However, the action proposed in the SNPRM and in this petition for exemption would not eliminate the known unsafe condition resulting from ignition sources caused by shorts within wiring and fuel gauging equipment on the subject airplane models. The National Transportation Safety Board identified this ignition source as the most likely cause of the catastrophic loss of all lives on the TWA Flight 800 airplane. This known fuel tank ignition source is required to be eliminated in all fuel tanks of airplane models affected by SFAR 88 and the FAA's own SFAR 88 Policy, published as Mandatory Corrective Action criteria in FAA Policy Statement No. 2003-112-15.
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> **Comment 1: SFAR 88 Exemption Required**
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> Section 2.(a) of SFAR 88 requires that the affected Design Approval Holders
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> > Conduct a safety review of the airplane fuel tank system to determine that the design meets the requirements of §§ 25.901 and 25.981(a) and (b) of this chapter. If the current design does not meet these requirements, develop all design changes to the fuel tank system that are necessary to meet these requirements.
>
> Therefore, all design changes required to comply with SFAR 88 must comply with Title 14, Code of Federal Regulations 25.901 at Amendment 25-46, and 25.981 at Amendment 25-102 (the amendment levels in [effect] on the effective date of SFAR 88).

The petition for exemption did not include a request for an exemption from this requirement of SFAR 88, and this requirement of SFAR 88 still requires the design change comply with the above sections.

NATCA submitted comments to the SNPRM that recommended the means of compliance for paragraph (b) clearly state in the final rule that the FQIS design changes must include all fuel tanks and modifications must comply with the fail safe requirements of 14 CFR 25.901, Amendment 25-46, and 14 CFR 25.981(a) and (b), Amendment 25-102. Compliance with those regulations is clearly required by SFAR 88 for all design changes required by SFAR 88.

Comment 2: Lack of Public Interest

During NATCA's review of the petition we believe that the petition does not meet the requirements for granting an exemption in 14 CFR section 11.81(e) and is not in the public interest. Section 11.81(e) requires the petition for exemption include "The reasons why granting the exemption would not adversely affect safety, or how the exemption would provide a level of safety at least equal to that provided by the rule from which you seek the exemption." The petitioner's justification for granting an exemption is based primarily on the cost of developing a compliant design and a statement of no adverse effect on safety because of features required by separate regulations. The costs associated with compliance are not a consideration for meeting the conditions in § 11.81(e) for granting an exemption. The statement in the petition for exemption of no adverse effect on public safety is not supported by safety standards established by the FAA in rulemaking. Following the TWA 800 accident resulting from a fuel tank explosion, the FAA amended § 25.981 to include requirements that address precluding creation of ignition sources as well as separate requirements to limit fuel tank flammability. All manufacturers are required to incorporate flammability reduction systems into airplanes operating in passenger service, including the 757, by the FAA's 2008 Fuel Tank Flammability Reduction rulemaking. However, they are not required to provide flammability reduction systems for the center wing tank in cargo airplanes. In addition, the FAA determined lack of separation between wiring that enters the fuel tanks and wiring carrying high power could result in ignition sources inside the fuel tanks.

As stated by the petitioner full compliance with § 25.901(c), which is in the original certification basis of the 757, and § 25.981(a)(3) at Amendment 25-102 or later would result in redesign of the FQPU, for wire separation inside and outside of all 3 fuel tanks. The petitioner's proposal to only separate wiring for a portion of the wiring outside of one fuel tank, the center wing fuel tank, is a significant reduction in the safety level provided by full separation for the wiring of all fuel tanks. The petitioner's claim that proposed maintenance checks of airplane wiring will be effective as a way to detect damaged wiring has not been proven. Isolating faults in airplane wiring, which are commonly intermittent, is very difficult. This has been shown when airplane wiring faults were found to be common, but were only detected when new fuel gaging system indicators were retrofitted into existing in service airplanes.

NATCA does not believe that granting the amendment to allow only partial wire separation for one of the three fuel tanks (the center wing fuel tank) is an overall safety improvement relative to a compliant design that would be required to have wire

separation for all fuel tanks together with separation of circuits in the FQIS processor. This argument should not be a consideration in the FAA analysis of the exemption request.

Although we are submitting comments [3 through 5] after the comment period closed on August 11, 2015, we request the FAA consider these comments when evaluating the petition for exemption. Since that SNPRM has not yet been published as a final rule AD, it would seem that taking final action on a petition for exemption that is related to a proposed AD should not precede the publishing of the final rule AD. Therefore, the FAA should have sufficient time to disposition our comments before taking final action on this petition for exemption. In addition, NATCA understands the DOT and FAA policy is to accept late comments if the final action has not been taken.

The following additional comments are provided on the justifications in the petition for exemption from the Title 14, Code of Federal Regulations 25.901(c) at Amendment 25-126, and 25.981(a)(3) at Amendment 25-125, pertaining to planned changes for the 757-200 (Freighters Only), 757-200PF Center Wing Tank (CWT) Fuel Quantity Indication System (FQIS) Fuselage Wiring Installation, Docket No. FAA-2015-2021.

Comment 3. "The FQIS system was previously shown compliant to §§ 25.1309 and 25.901(c) for TC and ATC; however, both §§ 25.901(c) [25-126] and 25.981(a)(3) [25-125] have additional failure combination requirements."

> NATCA Comment: The FAA Type Certificate Data Sheet A2NM states the original certification basis for the Model 757 airplanes includes Federal Aviation Regulations (FAR) Part 25 with Amendments 25-1 through 25-45 effective December 1, 1978. The amendments to section 25.901 since Amendment 25-40 have not changed requirements of section 25.901(c) from the requirements of Amendment 25-40. Therefore, the FQIS must not have been properly shown to be compliant to sections 25.901(c) and 25.1309 and should be redesigned to properly show compliance to the original certification basis of the Model 757.

Comment 4. "This exemption is being sought for the no single plus latent (greater than extremely remote) as is stated in § 25.981(a)(3) and interpreted by the FAA for § 25.901(c). An exemption is also being sought for the non-environmental aspects of § 25.901(c) provided by FAA interpretation, and the explicit § 25.981(a)(3) requirements of manufacturing variability, aging, wear, corrosion, and likely damage, as these considerations are already covered by airline maintenance of the type design of the airplane."

> NATCA Comment: Section 2.(a) of SFAR 88 requires the affected Design Approval Holders "Conduct a safety review of the airplane fuel tank system to determine that the design meets the requirements of Secs. 25.901 and 25.981(a) and (b) of this chapter. If the current design does not meet these requirements, develop all design changes to the fuel tank system that are necessary to meet these requirements." Therefore, all design changes required to comply with SFAR 88 must comply with Title 14, Code of Federal Regulations 25.901 at Amendment 25-46, and 25.981 at Amendment 25-102 (the amendment levels in [effect] on the effective date of SFAR 88). The petition for exemption did not include a request for an exemption from this requirement of SFAR 88, so this requirement of SFAR

still requires the design change comply with the above sections even if the FAA were to grant the requested petition for exemption.

Comment 5. The petition states it is related to the FAA Supplemental Notice of Proposed Rulemaking (SNPRM) 2011-NM-094-AD. NATCA submitted comments to the SNPRM that are identified as FAA Docket No. FAA-2012-0187-0027. NATCA Recommendations No. 1 equally applies to the petition for exemption and we have repeated that here as NATCA Comment 5 to the petition for exemption:

> NATCA Comment: NATCA recommends this means of compliance for paragraph (b) of the proposed AD (SNPRM) clearly state in the final rule that the FQIS design changes must include all fuel tanks and modifications must comply with the fail-safe requirements of 14 CFR 25.901, Amendment 25-46, and 14 CFR 25.981(a) and (b), Amendment 25-102. Compliance with those regulations is clearly required by SFAR 88 for all design changes required by SFAR 88.
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> **Require Design Changes for All Fuel Tanks:**
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> Paragraph (h) of the proposed AD, "Optional Actions for Cargo Airplanes" provides the following options as alternatives from the requirements of paragraph (g) for airplanes used exclusively for cargo operations:
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> > (1) Within 6 months after the effective date of this AD, record the existing fault codes stored in the FQIS processor and then do a BITE check (check of built-in test equipment) of the FQIS, in accordance with the Accomplishment Instructions of Boeing Service Bulletin 757–28–0136, dated June 5, 2014. If any fault codes are recorded prior to the BITE check or as a result of the BITE check, before further flight, do all applicable repairs and repeat the BITE check until a successful test is performed with no faults found, in accordance with Boeing Service Bulletin 757–28–0136, dated June 5, 2014. Repeat these actions thereafter at intervals not to exceed 750 flight hours, and
> >
> > (2) Within 72 months after the effective date of this AD, modify the airplane by separating FQIS wiring that runs between the FQIS processor and the center fuel tank, including any circuits that might pass through a main fuel tank, from other airplane wiring that is not intrinsically safe.

Neither of these alternate actions would bring the FQIS for the center tank or the main fuel tanks into compliance with the fail safe requirements of 14 CFR 25.901, Amendment 25-45, and 14 CFR 25.981(a) and (b), Amendment 25-102, as required by SFAR 88 and the SFAR 88 Policy published by the FAA as Mandatory Corrective Action criteria in FAA Policy Statement No. 2003-112-15.

The SNPRM references analyses performed by the FAA using the FAA Transport Airplane Risk Assessment Methodology (TARAM) Handbook, an attachment to FAA Policy Statement No. PS- ANM-25-05, Risk Assessment Methodology for Transport Category Airplanes. However, the TARAM Handbook requires following specific policy for higher-level regulations if they exist, and lists SFAR 88 as an example of regulations with specific higher-level policy.

Therefore, TARAM requires that the FAA follow the higher-level SFAR 88 policy published by the FAA as Policy Statement No. 2003-112-15. As stated in the Policy Statement:

> The purpose of this memorandum is to provide standardized policy for determining the need for mandatory action relative to the findings from the fuel system safety review required by Special Federal Aviation Regulation Number 88 (SFAR 88).

The combination of failures identified in the proposed 757 AD clearly meet the criteria for an unsafe condition requiring corrective action mandated by AD in Element 2.a of the SFAR 88 memorandum. Element 2.a defines "known combinations" of failures as failures that "must be addressed by corrective action" for low-flammability-exposure fuel tanks.

> **Element 2. Combination of failures**
>
> a) Fuel tanks with low flammability exposure time
>
> For fuel tanks with low flammability exposure time, known combinations of failures are considered an unsafe condition and must be addressed by corrective action (i.e. AD).
>
> **Known combinations of failures include** combinations of failures which have occurred in-service and are likely to occur on other products of similar type design (i.e. products with a similar design of the fuel system), and **combinations of failures which have been subject to mandatory corrective actions, following in-service findings, on products with a similar fuel system designs.**

NATCA is concerned that our comment to the 2012 NPRM was not correctly understood because the FAA response provided in the SNPRM did not address our concern. Our comment to the 2012 NPRM was that the FAA was not following Element 2.a of FAA SFAR 88 Policy Statement No. 2003-112-15. Instead of responding to Element 2.a, the FAA response in the SNPRM focused on Element 2.b of the SFAR 88 policy. The proposed action in the SNPRM is still not following the policy in Element 2.a of FAA SFAR 88 Policy Statement No. 2003-112-15. The failure mode that is the subject of the 2012 NPRM and this 2014 SNPRM is a known combination of failures that was first subject to mandatory corrective action by the FAA over fifteen years ago when, on September 30, 1998, the FAA published an AD to correct this same unsafe design feature for all fuel tanks on certain "classic" model Boeing 747 airplanes[2]. The unsafe condition was described in the preamble to the 1997 NPRM for the 747 AD:

> In support of the subsequent accident investigation, the FAA participated in testing of the fuel quantity indication system (FQIS). Results of that testing revealed that excessive energy could be induced by high transient voltage levels in the electrical wiring and probes of the fuel system. These excessive levels occurred when the wiring of the FQIS was subjected to electrical transient testing.

[2] AD 98-20-40, Federal Register Vol. 63, No. 189, page 52147, September 30, 1998. Boeing Model 747 –100, –200, –300, SP, and SR series airplanes

> These electrical transients may be caused in the airplane when switching electrical loads in the wiring adjacent to the FQIS wiring.
>
> The FQIS was tested to determine its performance in accordance with airplane electromagnetic interference (EMI) requirements. In this test, conductive debris, such as steel wool and lockwire, was used to bridge the FQIS probes to simulate debris that has been found during inspections of transport category airplanes. Results of this test indicated that transient voltage levels induced in the FQIS wiring and probes could be in excess of 800 volts, and the resulting energy levels in the FQIS wiring and probes could be greater than the energy required to ignite fuel vapor inside a fuel tank.
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> In addition, recent inspections of the fuel probe wiring in Model 747 fuel tanks revealed damaged wiring insulation, which exposed the conductors inside the fuel tank. This condition, together with the introduction of induced transients or short circuit conditions, increases the likelihood for potential ignition sources in the fuel tank.
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> The conditions described above, if not corrected, could result in excessive levels of energy in the FQIS wiring and a consequent potential source of ignition in the fuel tank.

The SNPRM disposition of NATCA comments says:

> The FQIS latent-plus-one vulnerability for Model 757 airplanes was classified as a theoretical vulnerability and not as a condition known to have occurred, the SFAR 88 corrective action policy does not require corrective action for that condition in low- flammability fuel tanks. The installation of an FRM causes the center fuel tank to meet the criteria for classification as a low-flammability fuel tank, and therefore FRM installation was considered to be acceptable mitigating action.

However, under “Unsafe Condition” in the AD proposed by the SNPRM the FAA states:

> This AD was prompted by fuel system reviews conducted by the manufacturer. We are issuing this AD to prevent development of an ignition source inside the center fuel tank caused by a latent in-tank failure combined with electrical energy transmitted into the center fuel tank via the fuel quantity indicating system (FQIS) wiring due to a single out-tank failure.

The Unsafe Condition in the AD proposed by the SNPRM describes the same failure mode that is described in the 1997 NPRM for the 1998 Model 747 AD that required design changes to eliminate the failure mode in *all* fuel tanks; low flammability exposure time and high flammability exposure time.

Therefore, the unsafe condition described in the SNPRM is a “Known Combination of Failures” as defined in Criteria 2.a as “combinations of failures which have been subject to mandatory corrective actions, following in-service findings, on products with a similar fuel system designs.”

The FAA's analysis

We agree with the petitioner's justification that granting the petition is in the public interest. Modification of existing in-service 757 airplanes to provide a compliant design would be costly because changing the fuel-quantity processor, separating airplane wiring from other high-power wiring, or providing electrical isolating devices to prevent electrical energy from entering the fuel tanks for the small number of cargo airplanes is cost prohibitive. This exemption will allow approval of service instructions needed to address an unsafe condition on the 757 center wing tank FQIS wiring. We received comments on the proposed exemption from NATCA.

Regarding NATCA comments 1 and 4:

> Section 2.(a) of SFAR 88 requires that the affected Design Approval Holders "Conduct a safety review of the airplane fuel tank system to determine that the design meets the requirements of Secs. 25.901 and 25.981(a) and (b) of this chapter. If the current design does not meet these requirements, develop all design changes to the fuel tank system that are necessary to meet these requirements."
>
> Therefore, all design changes required to comply with SFAR 88 must comply with Title 14, Code of Federal Regulations 25.901 at Amendment 25-46, and 25.981 at Amendment 25-102 (the amendment levels in effect on the effective date of SFAR 88). The petition for exemption did not include a request for an exemption from this requirement of SFAR 88, so this requirement of SFAR still requires the design change comply with the above sections even if the FAA were to grant the requested petition for exemption.

We agree with the NATCA comment that SFAR 88 requires the type-design-approval holder to develop all design changes to the fuel-tank system that are necessary to meet the requirements of §§ 25.901 and 25.981. The petitioner did not specifically request exemption from this requirement. However they did request an exemption from §§ 25.901 and 25.981. Granting the exemption to these sections results in granting an exemption to the same ignition-source prevention requirements of SFAR 88. Therefore, we have added clarification in the exemption that states that exemption from SFAR 88 for the service instruction is also included in this exemption.

Regarding NATCA comments 2, 3, and 5: NATCA comment 3 pointed out that the petitioner had stated that the 767 FQIS design had previously been shown to be compliant with §§25.901, 25.981, and 25.1309 as justification for the safety of the design. NATCA stated, "… the FQIS [design] must not have been properly shown to be compliant to §§25.901 (c) and 25.1309 and should be redesigned to properly show compliance to the original certification basis of the model 757." NATCA further stated, in comment 2 and 5, that granting the exemption would not be in the public interest, and that the action proposed in the SNPRM and in this petition for exemption would not eliminate the known unsafe condition resulting from ignition sources caused by shorts within wiring and fuel-gauging equipment on the subject airplane models. NATCA stated that the National Transportation Safety Board identified this ignition source as the most likely cause of the catastrophic loss of all lives on the TWA Flight 800 airplane. NATCA believes that this known fuel-tank ignition source is required to be eliminated in all fuel tanks of airplane models affected by SFAR 88, and the FAA's own SFAR 88 Policy, published as Mandatory Corrective Action criteria in FAA Policy Statement No. 2003-112-15. NATCA does not believe that granting the exemption to allow only partial wire separation for one of the three fuel tanks (the center wing fuel tank) is an overall safety improvement, relative to a compliant design, that

would be required to have wire separation for all fuel tanks together, with separation of circuits in the FQIS processor.

The FAA disagrees with the request to require modification of the FQIS in all fuel tanks. We agree that the Model 757 airplane FQIS has the same high-level system architecture and operating principles as those of the Model 747 airplane FQIS, resulting in vulnerability to the same theoretical latent-plus-one-failure scenario. There are, however, significant differences in the details of the Model 757 airplane FQIS design that reduce the likelihood of the individual contributing failures. Those differences include the following:

- Improved FQIS probe-terminal connector-block design.
- The use of wiring that is not silver plated and therefore does not create silver sulfide deposits on the terminal blocks.
- The use of improved wire types and wiring installation practices outside of the fuel tanks.
- The use of a system processor that significantly isolates the tank-probe circuits from the FQIS indication and power circuits.

We therefore did not consider that the FQIS designs for Model 747 and Model 757 airplanes were so similar that the Model 757 airplane FQIS design should be considered to have a "known" latent-plus-one-failure condition vulnerability as defined in the policy memorandum.

Service history of conventional, unheated, aluminum wing tanks that contain Jet A fuel indicates little safety benefit is gained by further limiting the flammability of the these tanks. Our review of nine wing-tank ignition events shows that 5 of the 9 airplanes were using JP-4 fuel, which is no longer used except on an emergency basis in the U.S. External heating of the wing due to engine fires caused three of the remaining four events, and the fourth event occurred on the ground during maintenance. To date, ignitions in conventional, unheated, aluminum wing tanks fueled with Jet A fuel have not resulted in fatalities. The flammability characteristics of JP-4 fuel result in the fuel tanks being flammable a significant portion of the time when an airplane is in flight. This is not the case for wing tanks containing Jet A fuel.[3] We do not consider it to be an unsafe condition for the FQIS wiring entering these tanks to be co-routed in wire bundles with wires carrying high electrical energies.

In summary, the FAA does not agree with the NATCA comment that changes to the fuel-quantity system proposed by Boeing will not address the unsafe condition, and that granting the exemption is not in the public interest. The FAA has determined that the proposed modifications represent a reasonable, cost-effective method to achieve a meaningful reduction in the risk due to potential FQIS fuel-tank-ignition sources. The FAA's current fuel-tank-safety airworthiness standards rely upon a balanced approach of limiting fuel-tank-flammability exposure time and precluding ignition sources that could form in the fuel tanks. For this reason, § 25.981 includes separate and distinct requirements for limiting fuel-tank flammability and preventing ignition sources in the fuel tanks. The wing and center wing tank safety are addressed by considering flammability and ignition source mitigations. The wing tanks are exposed to outside air, are unheated, naturally cool, and are considered low flammability. We do not consider it to be an unsafe condition for the FQIS wiring entering these tanks to be co-routed in wire bundles with

[3] See "Reduction of Fuel Tank Flammability in Transport Category Airplanes; Final Rule", Federal Register, Volume 73, No 140, Monday July 21, 2008, page 42456.

wires carrying high electrical energies. Because the center wing tank is heated and is considered a high-flammability tank, additional ignition-source mitigations are provided. The modifications to separate a portion of the wiring for the center wing tank FQIS significantly reduces the likelihood of a failure that could introduce high power onto the FQIS wiring. In addition, mandatory maintenance checks for the center tank FQIS wiring will be required as part of the petitioner's design approval. This will significantly reduce the likelihood of a latent failure in the FQIS wiring resulting in an ignition source in the fuel tanks. Granting this exemption will allow FAA approval of service instructions needed to address the unsafe condition and therefore result in a safety improvement that is in the public interest.

For clarity, we do not agree with the petitioner's public interest statements that "The time needed to successfully design and implement system changes beyond the proposed CWT FQIS wiring separation design changes, to comply with the rules, would further impact the availability of the wiring change on this out-of-production fleet of 757 aircraft." The AD worksheet for correcting this unsafe condition was issued in 2004. Boeing has not provided service instructions since that time. The time needed to develop a compliant design is minimal when compared to the delay by the petitioner in providing the service instructions. We did not consider this argument in our determination that granting the exemption is in the public interest.

We also do not agree with the petitioner's public interest statement "that the granting of this exemption would negate the need for FAA to evaluate the additional data required to support compliance with these regulations. Therefore, granting this exemption would reduce the burden on FAA resources and consequently public expenditure." FAA resources needed to review design changes that are needed for full compliance would be minimal, and these resources are available to address unsafe conditions. There would be no savings in public expenditure and no public interest by not providing a compliant design, and we did not consider this argument in our determination that granting the exemption is in the public interest.

The FAA's decision

In consideration of the foregoing, I find that a grant of exemption is in the public interest.

Therefore, pursuant to the authority contained in 49 U.S.C. 40113 and 44701 delegated to me by the Administrator, The Boeing Company, is hereby granted an exemption from SFAR 88, and §§ 25.901(c) and 25.981(a)(3), as they pertain to fuel-tank-ignition prevention associated with the FQIS , limited to in-service 757-200 (freighters only) and 757-200PF center wing tank (CWT) Fuel Quantity Indication System (FQIS) fuselage-wiring installation.

Issued in Renton Washington, on October 9, 2015.

/s/

Michael Kaszycki
Acting Manager, Transport Airplane Directorate
Aircraft Certification Service